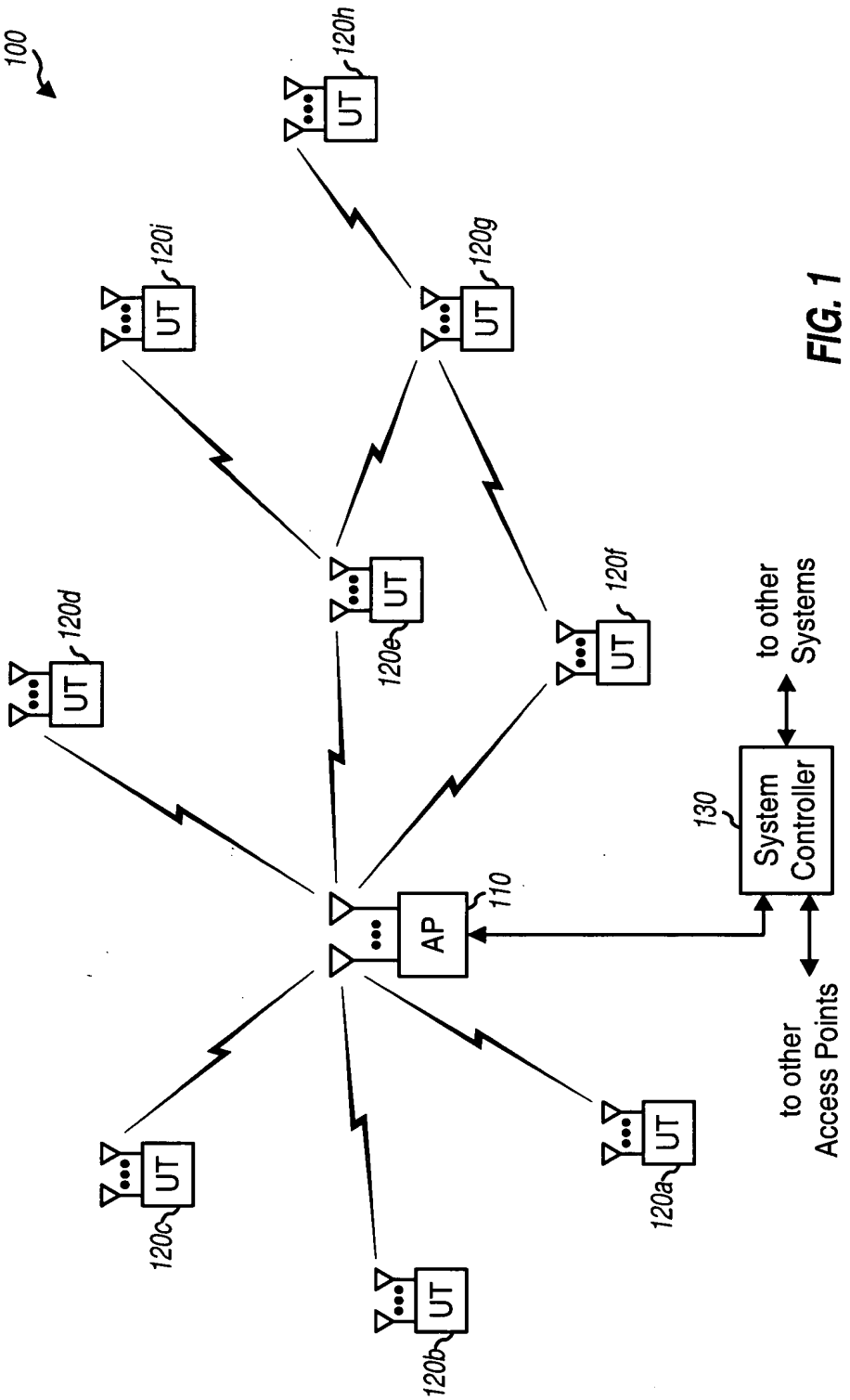
100
120h
UT
120i
UT
120g
UT
120d
UT
120e
UT
120f
UT
AP
110
130
System Controller
to other Systems
to other Access Points
120c
UT
120b
UT
120a
UT

FIG. 1

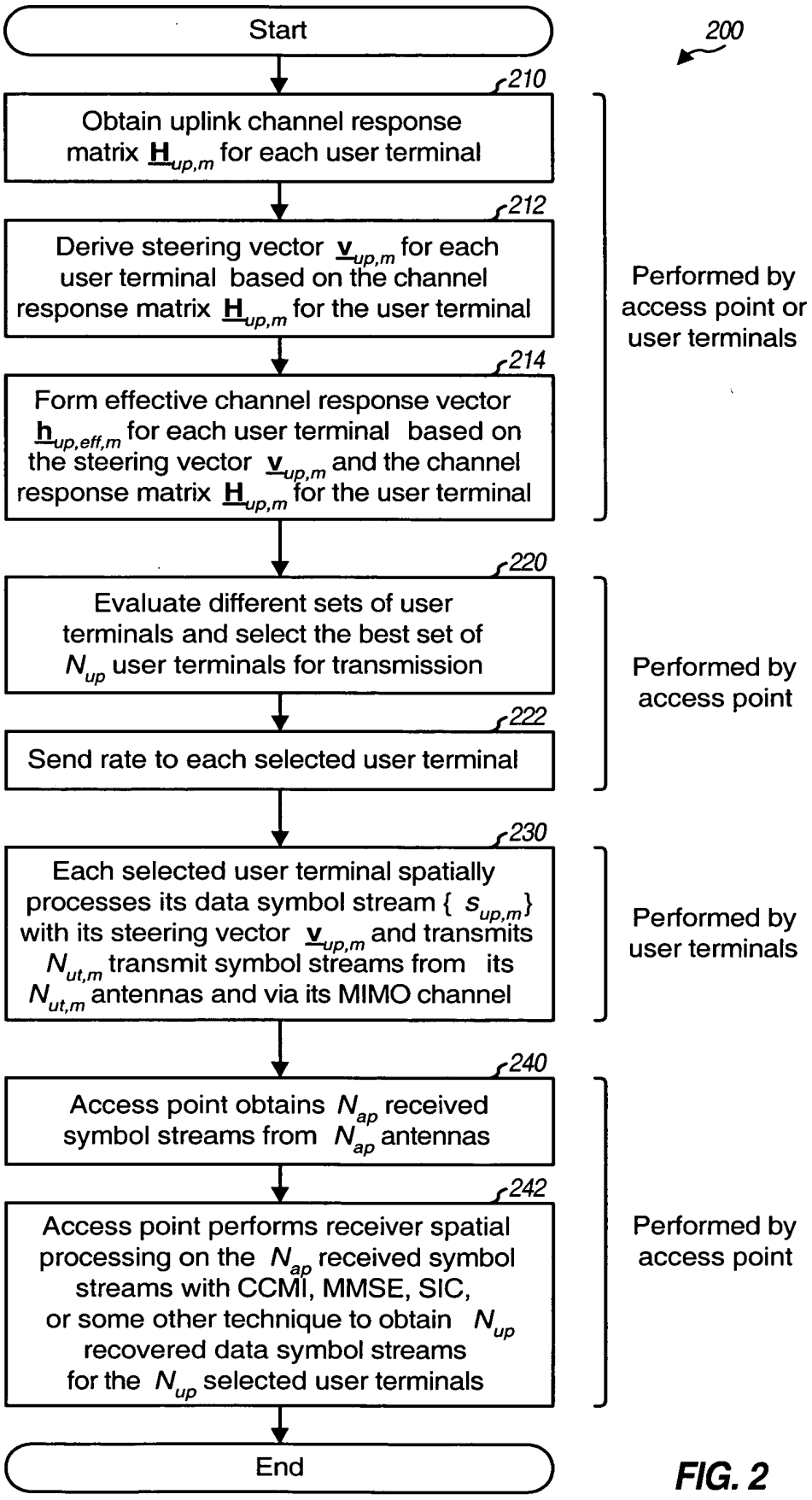
Start
200
210
Obtain uplink channel response matrix $\underline{\mathbf{H}}_{up,m}$ for each user terminal
212
Derive steering vector $\underline{\mathbf{v}}_{up,m}$ for each user terminal based on the channel response matrix $\underline{\mathbf{H}}_{up,m}$ for the user terminal
214
Form effective channel response vector $\underline{\mathbf{h}}_{up,eff,m}$ for each user terminal based on the steering vector $\underline{\mathbf{v}}_{up,m}$ and the channel response matrix $\underline{\mathbf{H}}_{up,m}$ for the user terminal
Performed by access point or user terminals
220
Evaluate different sets of user terminals and select the best set of N_{up} user terminals for transmission
222
Send rate to each selected user terminal
Performed by access point
230
Each selected user terminal spatially processes its data symbol stream $\{s_{up,m}\}$ with its steering vector $\underline{\mathbf{v}}_{up,m}$ and transmits $N_{ut,m}$ transmit symbol streams from its $N_{ut,m}$ antennas and via its MIMO channel
Performed by user terminals
240
Access point obtains N_{ap} received symbol streams from N_{ap} antennas
242
Access point performs receiver spatial processing on the N_{ap} received symbol streams with CCMI, MMSE, SIC, or some other technique to obtain N_{up} recovered data symbol streams for the N_{up} selected user terminals
Performed by access point
End

FIG. 2

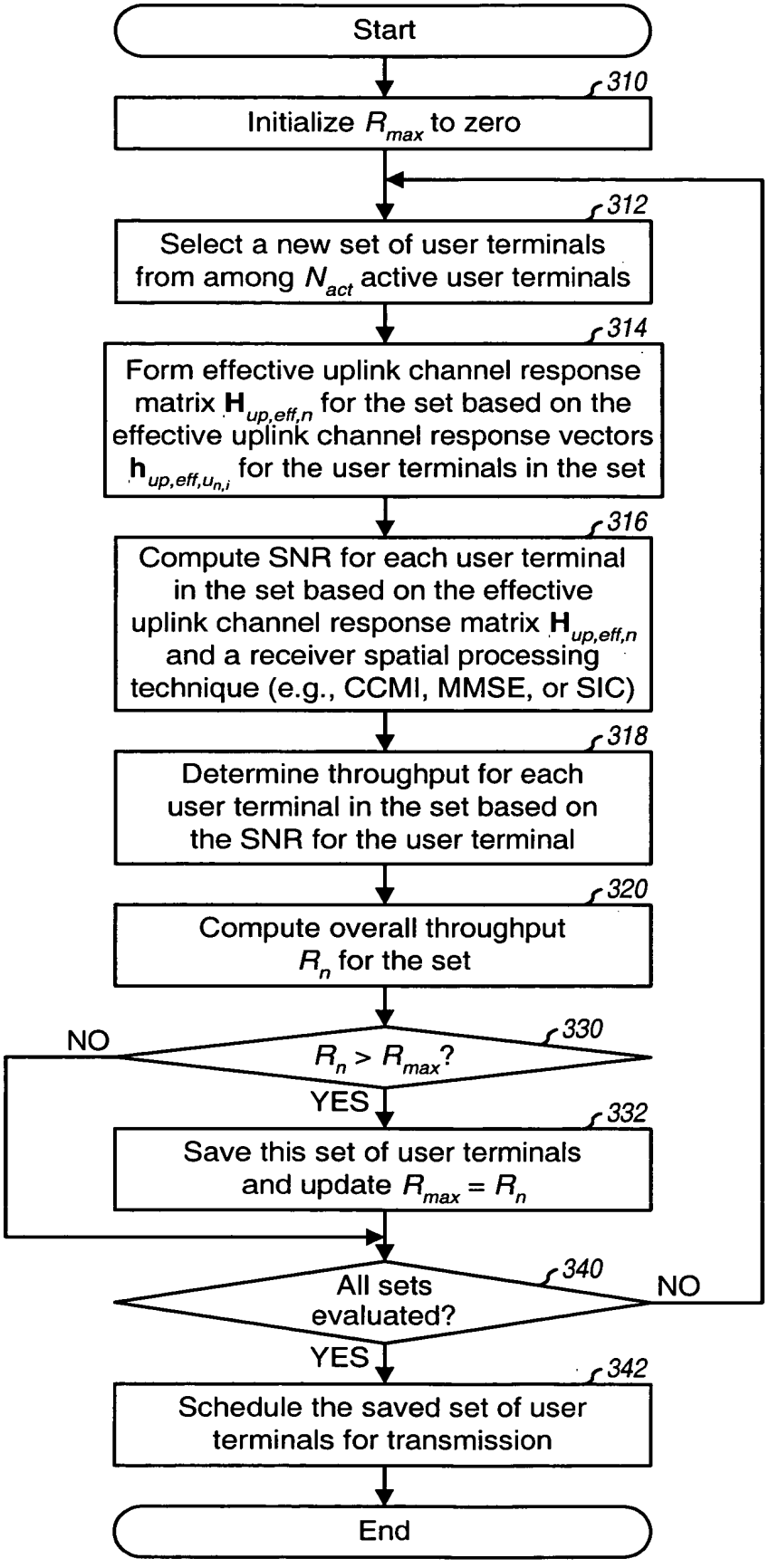
Start
220a
310
Initialize R_{max} to zero
312
Select a new set of user terminals from among N_{act} active user terminals
314
Form effective uplink channel response matrix $\mathbf{H}_{up,eff,n}$ for the set based on the effective uplink channel response vectors $\mathbf{h}_{up,eff,u_{n,i}}$ for the user terminals in the set
316
Compute SNR for each user terminal in the set based on the effective uplink channel response matrix $\mathbf{H}_{up,eff,n}$ and a receiver spatial processing technique (e.g., CCMI, MMSE, or SIC)
318
Determine throughput for each user terminal in the set based on the SNR for the user terminal
320
Compute overall throughput R_n for the set
330
$R_n > R_{max}$?
NO
YES
332
Save this set of user terminals and update $R_{max} = R_n$
340
All sets evaluated?
NO
YES
342
Schedule the saved set of user terminals for transmission
End

FIG. 3

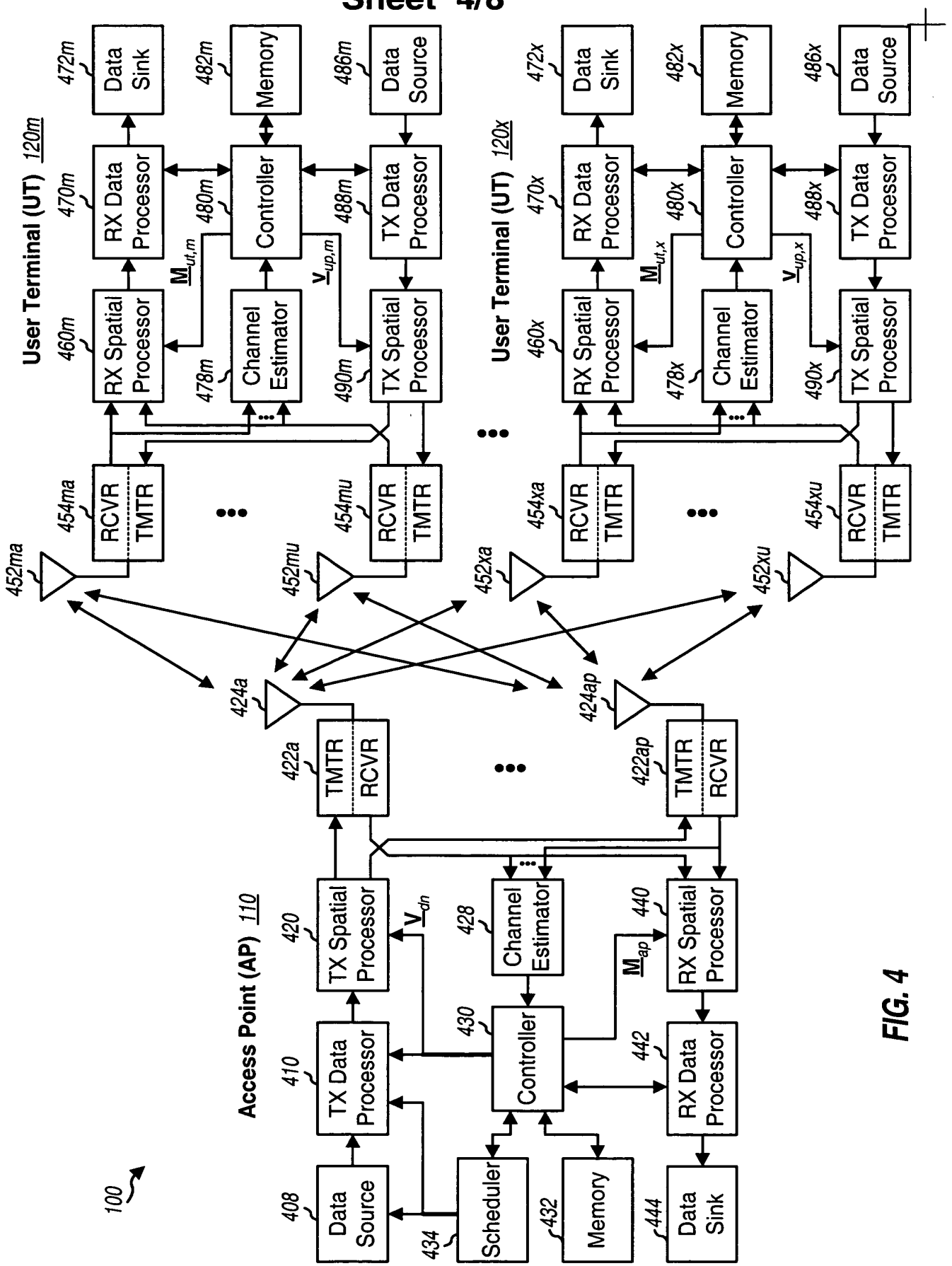
100
Access Point (AP) 110
User Terminal (UT) 120m
User Terminal (UT) 120x
Data Source 408
TX Data Processor 410
TX Spatial Processor 420
TMTR RCVR 422a
TMTR RCVR 422ap
424a
424ap
452ma
452mu
452xa
452xu
RCVR TMTR 454ma
RCVR TMTR 454mu
RCVR TMTR 454xa
RCVR TMTR 454xu
RX Spatial Processor 460m
RX Spatial Processor 460x
RX Data Processor 470m
RX Data Processor 470x
Data Sink 472m
Data Sink 472x
Channel Estimator 478m
Channel Estimator 478x
Controller 480m
Controller 480x
Memory 482m
Memory 482x
TX Spatial Processor 490m
TX Spatial Processor 490x
TX Data Processor 488m
TX Data Processor 488x
Data Source 486m
Data Source 486x
Scheduler 434
Controller 430
Channel Estimator 428
RX Spatial Processor 440
RX Data Processor 442
Memory 432
Data Sink 444
$\underline{M}_{ut,m}$
$\underline{v}_{up,m}$
$\underline{M}_{ut,x}$
$\underline{v}_{up,x}$
$\underline{v}_{dn}$
$\underline{M}_{ap}$

FIG. 4

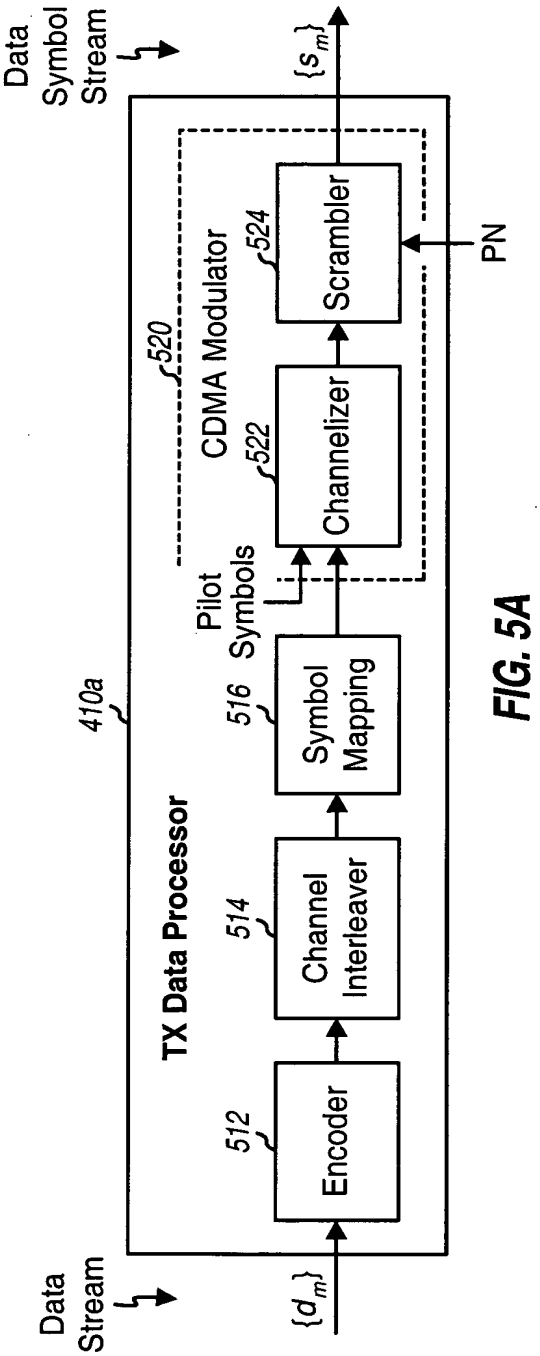
Data Symbol Stream
$\{s_m\}$
410a
520
CDMA Modulator
524
Scrambler
PN
522
Channelizer
Pilot Symbols
516
Symbol Mapping
514
Channel Interleaver
TX Data Processor
512
Encoder
Data Stream
$\{d_m\}$

FIG. 5A

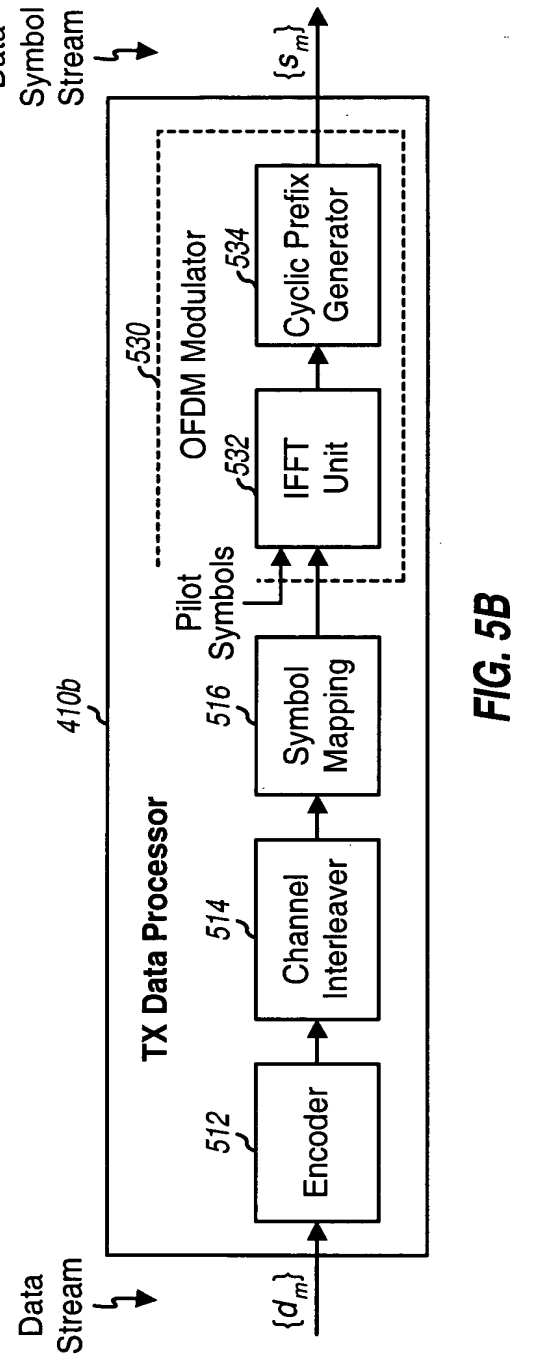
Data Symbol Stream
$\{s_m\}$
410b
530
OFDM Modulator
534
Cyclic Prefix Generator
532
IFFT Unit
Pilot Symbols
516
Symbol Mapping
514
Channel Interleaver
TX Data Processor
512
Encoder
Data Stream
$\{d_m\}$

FIG. 5B

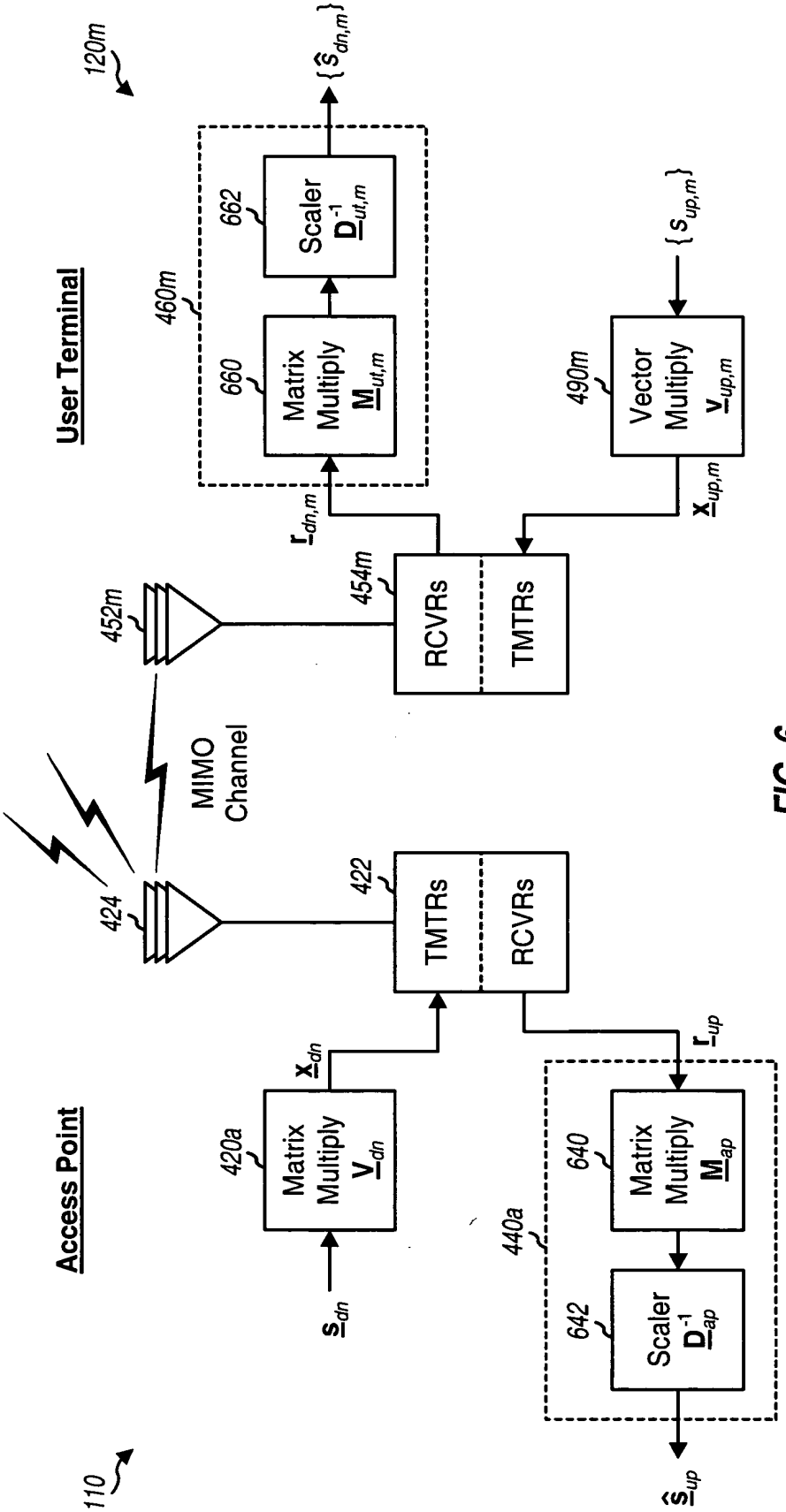
120m
User Terminal
460m
662
Scaler
$\underline{D}^{-1}_{ut,m}$
660
Matrix
Multiply
$\underline{M}_{ut,m}$
$\{\hat{s}_{dn,m}\}$
$\underline{r}_{dn,m}$
490m
Vector
Multiply
$\underline{v}_{up,m}$
$\{s_{up,m}\}$
$\underline{x}_{up,m}$
454m
RCVRs
TMTRs
452m
MIMO
Channel
424
422
TMTRs
RCVRs
Access Point
420a
Matrix
Multiply
$\underline{V}_{dn}$
$\underline{x}_{dn}$
$\underline{s}_{dn}$
$\underline{r}_{up}$
440a
640
Matrix
Multiply
$\underline{M}_{ap}$
642
Scaler
$\underline{D}^{-1}_{ap}$
$\hat{\underline{s}}_{up}$
110

FIG. 6

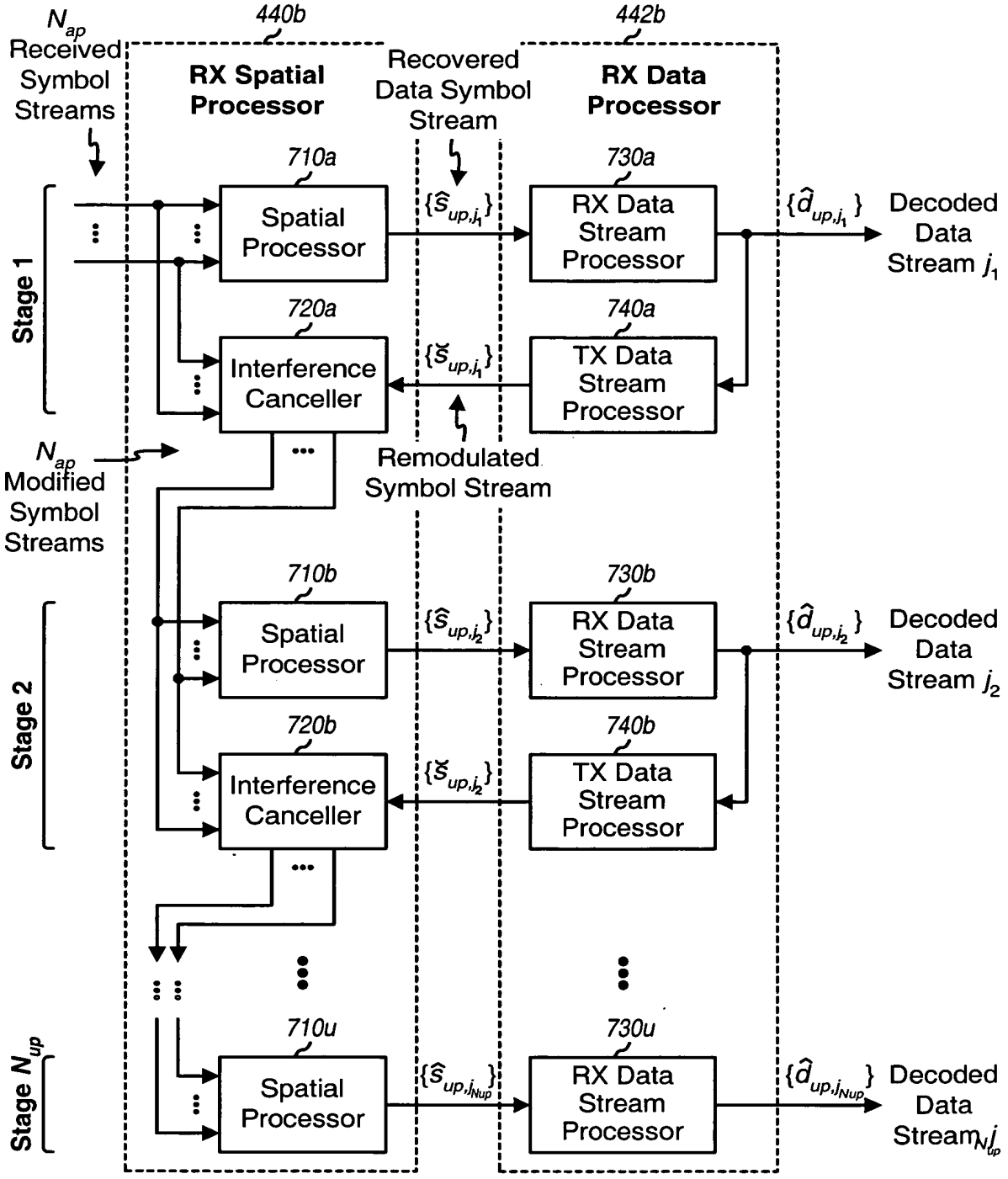
N_{ap} Received Symbol Streams
440b
442b
RX Spatial Processor
Recovered Data Symbol Stream
RX Data Processor
710a
730a
Spatial Processor
$\{\hat{s}_{up,j_1}\}$
RX Data Stream Processor
$\{\hat{d}_{up,j_1}\}$
Decoded Data Stream j_1
Stage 1
720a
740a
Interference Canceller
$\{\tilde{s}_{up,j_1}\}$
TX Data Stream Processor
N_{ap} Modified Symbol Streams
Remodulated Symbol Stream
710b
730b
Spatial Processor
$\{\hat{s}_{up,j_2}\}$
RX Data Stream Processor
$\{\hat{d}_{up,j_2}\}$
Decoded Data Stream j_2
Stage 2
720b
740b
Interference Canceller
$\{\tilde{s}_{up,j_2}\}$
TX Data Stream Processor
710u
730u
Stage N_{up}
Spatial Processor
$\{\hat{s}_{up,j_{Nup}}\}$
RX Data Stream Processor
$\{\hat{d}_{up,j_{Nup}}\}$
Decoded Data Stream j_{Nup}

FIG. 7

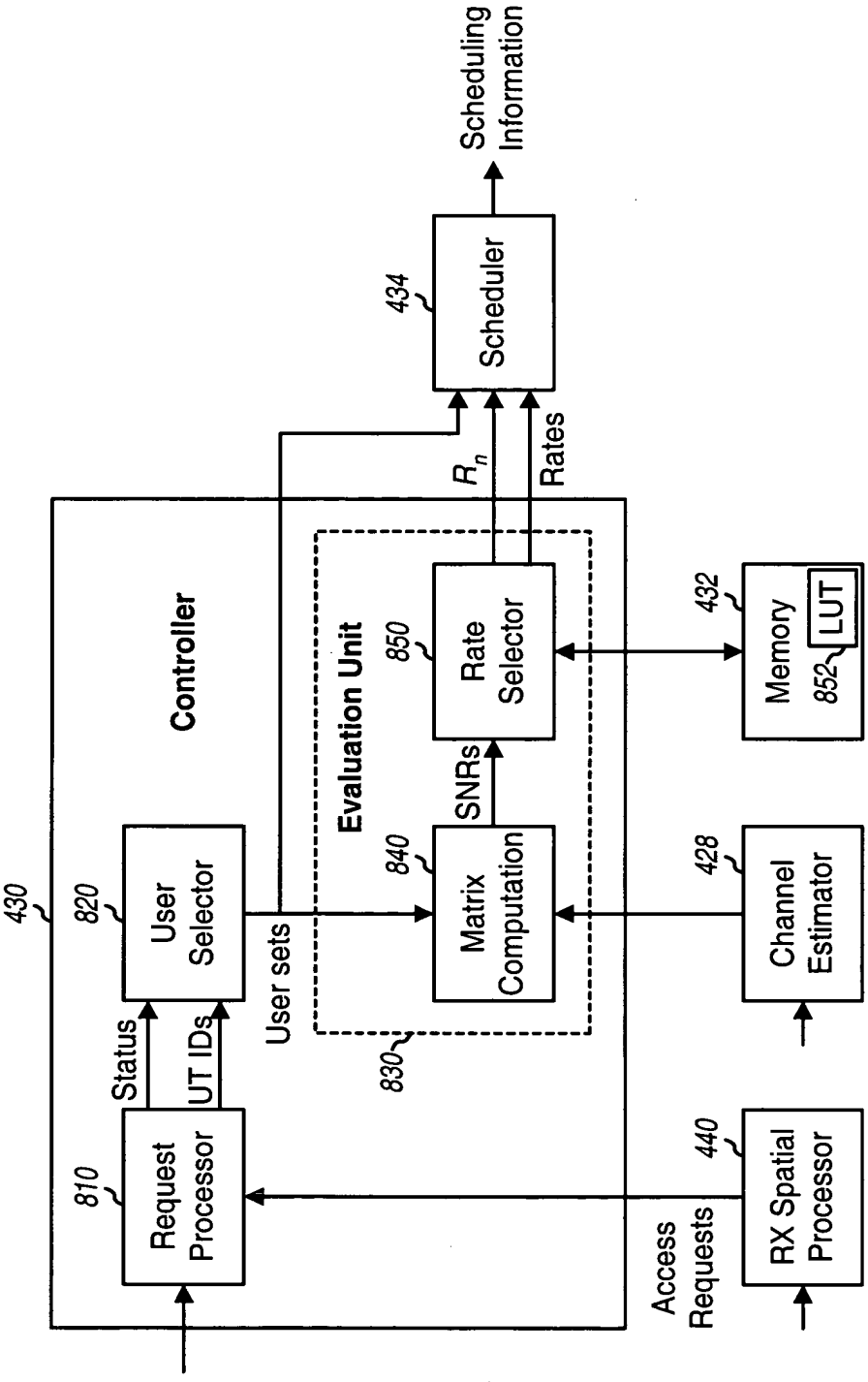
Scheduling Information
434
Scheduler
R_n
Rates
Controller
Evaluation Unit
850
Rate Selector
SNRs
840
Matrix Computation
830
User sets
820
User Selector
430
Status
UT IDs
810
Request Processor
Access Requests
440
RX Spatial Processor
428
Channel Estimator
432
Memory
852
LUT

FIG. 8